BRIMSTONE

DETAILED UXO RISK ASSESSMENT

STAGE 2 DETAILED UXO RISK ASSESSMENT

Client:	Lewisham Council		
Project Ref:	RENK01R		
Site Name:	Land Between 43 and 45 Camplin Street, Lewisham		
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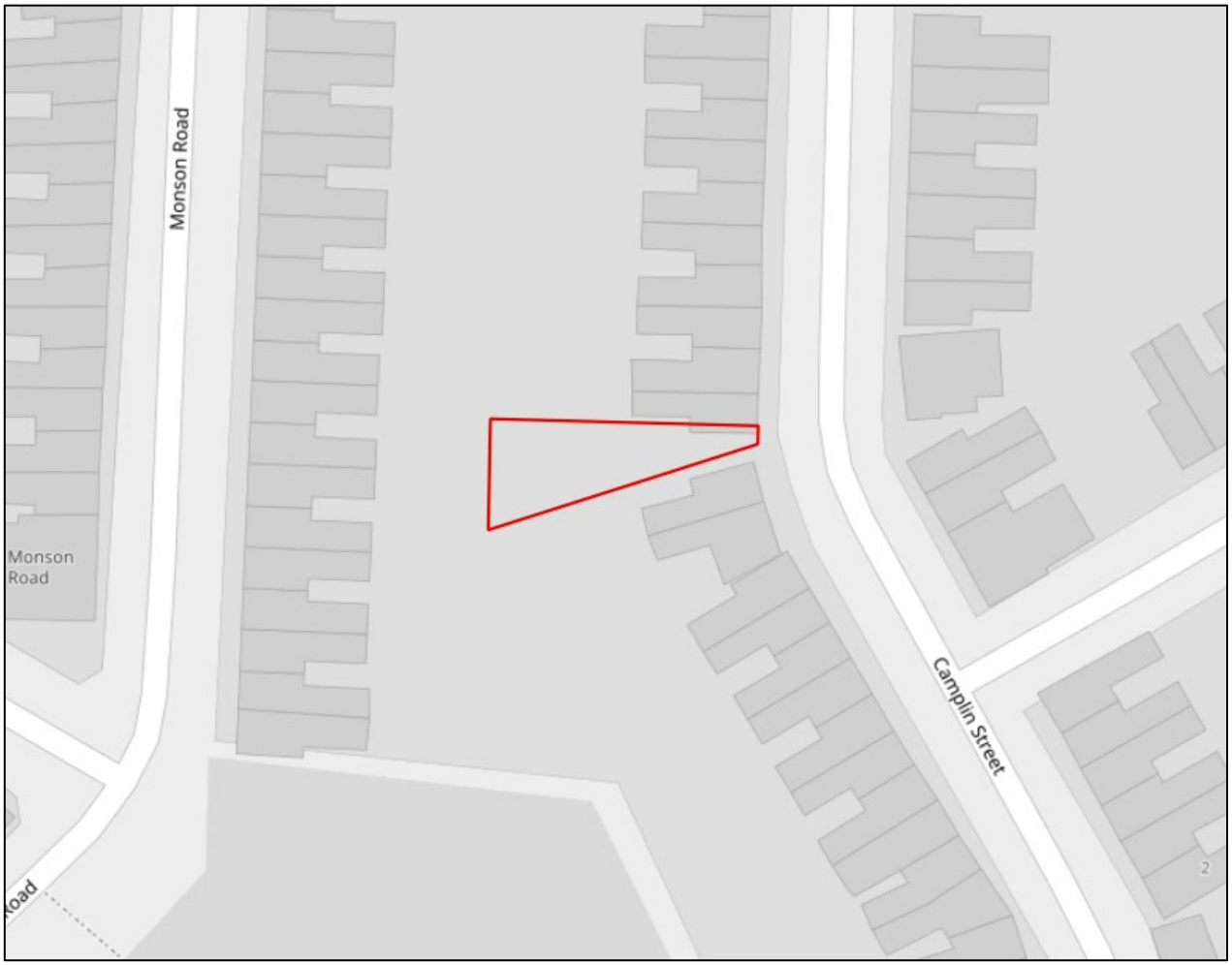

EXECUTIVE SUMMARY

RESULT: Brimstone concludes that unexploded ordnance (UXO) poses a **MODERATE RISK** to the proposed works.

THE SITE: The Site is located within the London Borough of Lewisham, approximately 550m north-west of New Cross Gate railway station. The Site comprises hardstanding with mature vegetation at the western extent and multiple small allotment containers present intermittently.

The Site is bound to the north and south by residential structures, to the east by Camplin Street, and to the west by associated gardens of residential structures on Monson Road.

Grid Reference: TQ 35744 77287 **What3Words:** resort.fumes.clock

THE PROPOSED WORKS: Brimstone was not made aware of any future site investigation (SI) and development works at the time of writing.

UXO RISK ASSESSMENT:

German UXO:

- London was the most frequently and heavily bombed British city during World War Two (WWII). Indeed, the Site was located within the Metropolitan Borough of Deptford, which sustained 495.5 bombs / 1,000 acres, a very high bombing density according to the official Home Office bombing statistics. The nearest primary target identified by the Luftwaffe was a gas works approximately 885m north-west of the Site. An engineering works, located approximately 160m north-east, may have been identified as a target of opportunity.
- The Site's situation in a borough with a very high bombing density is evident in the London bomb census mapping, which records one incendiary bomb shower over the Site and a further 36 high explosive (HE) bomb strikes within an approximate 250m radius of the Site. The closest HE strike is plotted approximately 15m west of the Site.
- The damage likely resulting from this bomb strike is documented within the London County Council (LCC) bomb damage mapping, the structures immediately north and south of the Site were coloured yellow, indicating they sustained 'blast damage – minor in nature' and the structure 15m west of the Site is recorded as being totally destroyed, which aligns with the plotting of the HE bomb strike. It should be noted that the majority of the structures within the study area (approximate 250m radius) are recorded as sustaining varying degrees of damage, resulting from the very high local bombing density.
- Both WWII-era and post-WWII aerial photography corroborate this damage, displaying areas of structural clearance located approximately 15m and 50m west, 45m north-east, 80m and 105m south-east and 155m south of the Site (see **FIGURE 5.4**). Additionally, multiple residential structures have been identified as undergoing roof repairs, located approximately 25m west and 45m south-east of the Site, in photography dated 1941 and 1947.
- Wartime access levels to the Site are anticipated to have been intermittent during the war, due to its proximity and likely association with the adjacent residential properties. However, the blast damage sustained to these properties may have resulted in a temporary evacuation while repairs were conducted, which would have drastically decreased access levels. It is possible during this period that a UXB strike occurred unnoticed and unreported.

- From analysis of WWII-era photography, it appears the Site comprised undeveloped, open ground with mature vegetation present in the western and south-western extents of the Site. This will have likely created conditions where evidence of an unexploded bomb (UXB) strike could become obscured and remain undetected. Moreover, the Site was bound to the north, south and west by associated gardens of residential properties, where ground cover conditions were likely unconducive to the detection of UXBs. This means the Site was vulnerable to the J-Curve Effect, wherein a UXB may travel laterally from its point of penetration and come to rest in a different location (see ***Section 6.3.2***).
- In conclusion, the Site was located in a London Borough which suffered heavy German bombardment. The Site is recorded as suffering an incendiary bombing incident, and it is evident the immediate surrounds of the Site were severely affected by German bombing. In addition, conditions on Site were unconducive to the visual detection of UXBs, and minimal post-war redevelopment appears to have occurred on Site, therefore any potential German UXB may remain in situ. Consequently, the Site has been assessed as **Moderate Risk** from German UXO contamination.

British / Allied UXO:

- No evidence of historic military activity within the Site boundary has been found and it is highly unlikely that any has occurred historically, owing to the Site's situation with a residential area. Consequently, the risk from associated UXO is **Low.**
- Numerous (>40) permanent heavy anti-aircraft (HAA) batteries were active within range of the Site during WWII. Light anti-aircraft (LAA) guns likely defended vulnerable points within the borough. Luftwaffe activity was frequent and intense over the wider area and therefore these would have expended a vast quantity of ammunition. The risk of encountering this type of UXO is considered analogous with that of German UXBs and has subsequently been assessed as **Moderate Risk.**

Likelihood of UXO Remaining and UXO Encounter:

- Minimal post-WWII works have been conducted on Site. The construction of the small structure in the north-eastern section of the Site and its subsequent clearance likely involved excavations which partially intruded into shallow (1-2m bgl) depths. The laying of hardstanding post-conflict would have disturbed WWII-era soil to very shallow (<1m bgl) depths.
- The risk associated with any very shallow buried UXO will have been largely mitigated across the majority of the Site, in the footprint of post-war hardstanding. The risk associated with any shallow buried UXO may be partially mitigated in the footprint of the post-WWII structure in the north-eastern extent of the Site. The risk associated with any deep (>2m bgl) buried UXO almost certainly remains unmitigated.

RECOMMENDED RISK MITIGATION MEASURES: The measures detailed below are recommended to mitigate the risk to ALARP level.

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings	Prior to all intrusive works commencing.
Intrusive Magnetometer Probe Survey	Of all pile positions.
EOD Engineer - On Site Supervision	Watching brief of all open excavations and magnetometer survey of all borehole locations.

CONTENTS

FIGURES

APPENDICES

QUALITY POLICY

Brimstone Site Investigation Ltd, known as Brimstone, is committed to the delivery of unexploded ordnance (UXO) risk mitigation services, including safe removal and disposal of explosive ordnance, in the UK and overseas. Since our incorporation in 2016 it has been our goal to provide unsurpassed and unbiased UXO risk mitigation services. Brimstone is a client-centric organisation, with the aim to provide the client the services they need, to the agreed requirement, in accordance with national and international standards or standard operating procedures.

We are committed to providing a safe, cost-effective, and quality service, underpinned by our core values:

- **Integrity:** We are unwavering in our commitment to providing pristine, unbiased counsel and superior services. Our ethical compass guides every interaction, ensuring we maintain the highest standards of conduct in all our endeavours.
- **Professionalism:** We embody professionalism at every level, conducting our business with unparalleled excellence. Our commitment to quality guarantees top-tier service and a seamless experience for every client.
- **Knowledge:** We are devoted to perpetual growth, consistently expanding our expertise to stay at the forefront of industry innovation and strategy. Our thirst for knowledge ensures we are equipped to lead and succeed in an evolving marketplace.
- **Innovation:** We champion innovation, continuously advancing our services and processes. Our pursuit of inventive strategies and pioneering solutions ensures we not only meet but exceed the evolving needs of our clients and the industry.

We are committed to the applicable requirements of the ISO 9001:2015 standards. We set and review quality monitoring objectives using the plan, do, check, act cycle to measure the performance of our quality management system. Brimstone wholly endorses the ethos of 'continual improvement efforts' and allocates resources to meet this requirement.

This policy applies to the whole of the Brimstone services and involves all personnel including the managing director. All personnel are responsible for helping manage quality, seeking improvement through constant review, and by encouraging supplier and subcontractor involvement. We are committed to achieving customer satisfaction using quality procedures, which will be operated to meet or exceed the applicable requirements of ISO 9001.

Aaron Florence
Founder and Managing Director
Brimstone Site Investigation Ltd.

1 INTRODUCTION

1.1 Background

Lewisham Council (the Client) has commissioned Brimstone to carry out a Stage 2 Detailed Unexploded Ordnance Risk Assessment (DRA) of the proposed redevelopment works at the Land Between 43 and 45 Camplin Street, Lewisham site (the Site).

1.2 Legislation

There are no regulations that specifically govern the UXO risk mitigation industry in the UK. However, there are two pieces of legislation that require consideration. It is industry best practice (and common sense) to frame your site in the context of UXO, and to put in place measures to protect people from risks. In 2009, CIRIA published Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681. This publication, though not legally binding, provides the gold-standard framework to which UXO and construction companies operate.

1.2.1 Construction Design and Management Regulations (CDM) 2015

The regulations identify the client, the CDM coordinator, the designer, and the principal contractor as responsible parties. Under the regulations, responsible parties are held accountable for the way a construction project is managed and for the health and safety of workers. Responsible parties must:

- Provide an appropriate assessment of potential UXO risks, or ensure an assessment is completed by another party.
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks.
- Ensure the preparation of an emergency response plan.

1.2.2 The Health and Safety at Work Act 1974

The Health and Safety at Work Act 1974 had a transformative impact on health and safety, saving thousands of lives since its enactment. Employers must consider their employees, workers not in their employment, and members of the public. The act places a duty on every employer 'as far as is reasonably practicable' to protect workers from risks. It also says that information must be provided about aspects of health and safety that affect their role.

1.3 Commercial Contractor and the Authorities

1.3.1 Commercial Contractors

If your site has been given a moderate or high-risk rating, then control measures will be recommended. The measures will be specific to the scope of works on site, usually in relation to the depth and extent of excavations, piling and similar activities. There are a range of different methods at Brimstone's disposal, including:

- Non-intrusive surveying (including drone surveying)
- Intrusive surveying
- Search and clear
- Watching brief
- Support to geotechnical investigations
- Target investigation
- Site-specific training packages
- Site safety briefings

Our UXO Engineers can assess suspicious items on site when they are found. This will avoid unnecessary site evacuations. If our engineer(s) decide the item is UXO, they will coordinate with the authorities, manage disruptions, and advise on control measures, such as evacuations and a cordon.

1.3.2 UK Authorities

If Brimstone is not on site and a suspicious item is found, the local police must be immediately called on the non-emergency number. Police will visit the site. They will then inform the Joint Services Explosive Ordnance Disposal (JSEOD) office, which will coordinate the callout of an army or navy response team.

A precautionary cordon will initially be put into effect, with possible evacuation of homes and businesses, road and rail closures. The cordon may be extended following the advice from JSEOD's response team.

To manage their resources, JSEOD triages incidents. A consideration of the type, size and location of the UXO is made. If an incident is not given a high priority rating, a team may not be available for up to two days following the initial report.

The use of JSEOD is under the Military Aid to Civil Authorities (MACA) framework, therefore the budget and personnel is limited, and there are no statutory obligations made of the MOD. Often the MOD will recommend involvement of a commercial UXO contractor to manage the ongoing risk – this is especially true of former airfields and training areas where contact with land service ammunition can be frequent.

1.4 UXO Risk in the UK

Fortunately, to the best of our knowledge, there has not been a single post-war incident in the UK where a construction worker has been killed or injured because of an item of UXO exploding. There have been cases in mainland Europe where UXO had been struck and then exploded, killing workers. In 2019, a WWII general purpose bomb spontaneously detonated in a field north of Frankfurt, Germany.

However, the incident in Frankfurt is not comparable to the UK, due to the way different countries manufactured ordnance. Bombs made in different countries have different associated hazards. British WWII bombs, for example, have a fuzing system which uses chemicals which makes them very unsafe. Please see **APPENDIX 1** for recent examples of UK UXO incidents.

Between 2013 and 2016 JSEOD responded to 7,500 callouts. These callouts range from falsely identified objects, inert objects, small items of UXO and large WWII German unexploded bombs (UXBs). Each year the construction industry inadvertently unearths UXO; often this goes unreported. UXO contamination comes from three main sources:

- **Enemy action:** during WWI and WWII the air forces of Germany, and to a lesser extent Italy, bombed targets throughout the UK. The German navy bombarded several coastal targets in eastern England during WWI and then in WWII German long-range artillery on the French coast bombarded parts of Kent.
- **Allied military activity:** during WWI and WWII several Allied nations used the UK as a staging area for military action in the European Theatre; predominantly the US and Canada.
- **UK military activity:** domestic British Army, Royal Air Force (RAF) and Royal Navy (RN) training activities during peacetime and conflict as well as anti-aircraft gun and rocket batteries during WWI and WWII.

1.5 UXO Detonations

A detonation is a violent chemical reaction which creates a huge volume of gas. This reaction appears to happen instantaneously – the velocity of the shockwave moving is up to 9,000m per second. This chemical reaction is started using a small amount of very sensitive explosives called primary explosives. These types of explosives are highly sensitive to shock, friction, heat, and spark. As the explosive charge undergoes high order decomposition (detonation), the brisance, or shattering effect, causes the casing to splinter, projecting razor-sharp shrapnel across long distances.

The blast wave effect and the shrapnel effect can cause significant damage. Calculating safety distances is a complex process. As a rule of thumb, in open ground, a 250kg explosive charge (as would be found inside a typical 500kg bomb) would require an omnidirectional safety distance of at least 1.6km.

Bombs work by amplifying the explosive charge from the sensitive primary explosive through to the main charge or fill of the item. This process is called an explosive train, if any link in that chain is broken, the item will fail to function as intended. This can be due to mechanical, electrical, or manufacturing tolerances or faults. Amongst other reasons, detonation of UXO could occur under the following circumstances:

- **UXO body impact:** A substantial impact onto the main body of a UXO; borehole rigs, piling rigs, jack hammers and mechanical excavator buckets.
- **Fuse impact:** Environmental conditions during decades of burial can result in the primary explosives located in the fuse pocket to crystallise and become shock sensitive. It would then take a relatively small impact or friction impact to cause the fuse to function and detonate the UXO.
- **Re-starting a timer:** A small proportion of German WWII bombs used clockwork fuses. In 2002, an Army EOD Engineer reported that the clockwork fuse in a UXB re-started. Decades of burial causes substantial corrosion in WWII German UXBs and therefore an incident such as this is extremely rare.

2 ASSESSMENT METHODOLOGY

2.1 Introduction

This assessment has been produced in accordance with the relevant CIRIA guidelines; *Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681* (published in 2009). CIRIA C681 is a publication which originated from round table best practice discussions from industry leaders.

2.2 Source, Pathway, Receptor, Consequence Risk Model

The Source, Pathway, Receptor, Consequence (SPRC) risk model can be applied to buried UXO as follows:

- **Sources:** UK and Allied UXO sources include military firing ranges, bases, storage depots, munitions factories, anti-aircraft batteries, amongst others. There are many wartime causes of UXO contamination. The source for enemy contamination is overwhelmingly from WWII German air raids.
- **Pathways:** the pathway describes how the UXO reaches receptors. Usually, UXO is buried and therefore pathways can be any activity which involve breaking ground. Examples include ground investigation works, site enabling works and excavations.
- **Receptors:** receptors are the people, assets and infrastructure that can be adversely affected by UXO exposure. This includes site personnel, plant, equipment, buildings, the general public, and the environment.
- **Consequence:** the consequences of an inadvertent UXO detonation are catastrophic. They include injury and loss or life, as well as damage to property. Fortunately, the likelihood of UXO detonating is low, even when it is uncovered during works. However, another consequence to consider is delays to works, which itself can be a risk.

2.3 Assessment Structure

In accordance with CIRIA C681 this assessment addresses the following considerations in the appropriate order:

- The likelihood that the site was contaminated with UXO.
- The type of UXO that could have contaminated the site, and their associated hazards.
- The likelihood that UXO remains on the site.
- Theoretical bomb penetration depths.
- The likelihood that UXO will be uncovered during the proposed works.
- Risk rating and risk mapping (as appropriate).
- Risk mitigation recommendations.

2.4 Information Sources

To complete this risk assessment, Brimstone has gathered information from a wide range of sources. Brimstone's research team has completed detailed historical research, including access of original archived records. The list below is a general list of information sources that are consulted during the research process. For Site-specific sources consulted for this risk assessment, please refer to **APPENDIX 5**.

- The National Archives,
- Local archive centres,
- Ministry of Defence,
- The Council for British Archaeology,
- Groundsure mapping services,
- Historical aerial photography (Historic England, Britain from Above, NCAP),
- Google open-source mapping,
- The British Geological Survey,
- Open sources; published book, articles, web resources,
- Site-specific information supplied by the Client,
- Brimstone's library and historical database, and
- Brimstone's former armed forces employees.

2.5 As Low as Reasonably Practicable Principle

The ALARP (as low as reasonably practicable) principle corresponds to the actions that should be taken to reduce risks. The term 'ALARP' is in the Health and Safety at Work Act 1974, which says that risks must be controlled in a reasonable way.

Infinite time, effort and money could be spent trying to eliminate risk entirely. HSE uses the example that spending £1m to prevent five employees bruising their knees is disproportionate, whereas spending the same amount to prevent an explosion which could kill 150 people is proportionate.

Using this principle, Brimstone aims to reduce client costs by recommending strategies that are proportionate to the assessed risks, if any elevated risk is found at all.

2.6 Risk Tolerances

The Brimstone risk assessment process divides UXO risk into two tolerances:

- **Tolerable:** Low Risk and Low-Moderate Risk ratings are tolerable. Where the risk cannot be completely discounted, it may be a useful strategy to opt for a low-cost measure, such as a UXO safety briefing from a qualified UXO engineer.
- **Intolerable:** Moderate, Moderate-High, and High-Risk ratings are intolerable. Proactive risk mitigation measures should be put in place. Various strategies are at Brimstone's disposal to meet your project-specific needs.

2.7 Mapping/Imagery Accuracy Disclaimer

The information presented in any drawings, maps, or images has been compiled from a variety of sources, where possible, and is provided for general reference only. While Brimstone makes every effort to ensure the accuracy and completeness of this information, it may contain errors or omissions and should not be relied upon as definitive. Brimstone disclaims any liability for the misuse or misinterpretation of the information and makes no warranties or representations, express or implied, regarding its accuracy, completeness, or suitability for any particular purpose. Please contact Brimstone for further information regarding a map or image and further information can be provided where possible.

2.8 Reliance and Limitations

This report has been prepared using published information and information provided by the Client. Brimstone is not liable for any information which has become available following the publication of this report. No third-party liability or duty of care is extended. Any third-party using information contained in this assessment do so at their own risk.

3 THE PROJECT

3.1 The Site

The Site is located within the London Borough of Lewisham, approximately 550m north-west of New Cross Gate railway station. The Site comprises hardstanding with mature vegetation at the western extent and multiple small allotment containers present intermittently.

The Site is bound to the north and south by residential structures, to the east by Camplin Street, and to the west by associated gardens of residential structures on Monson Road.

Grid Reference: TQ 35744 77287 **What3Words:** resort.fumes.clock

FIGURE 1: Site Location Maps **FIGURE 2:** Recent Aerial Photograph

3.2 The Proposed Works

Brimstone was not made aware of any future SI and development works at the time of writing.

FIGURE 3: Existing Site Plan

4 SITE HISTORY

4.1 Site Introduction

Site-specific history can be assessed by reviewing historical mapping, historical aerial photography and by carrying out additional Site-specific research where appropriate. Below are descriptions of a selection of records relevant to the Site:

4.2 Mapping

The below table describes the composition of the Site, structural changes in pre- and post-WWII Ordnance Survey (OS) editions, and relevant points of interest. All maps were retrieved from National Library Scotland (NLS) online database and the Landmark Promap OS database.

Period	Map Date	Map Scale	Review
Pre-WWI	**1894**	**1:2,500**	The Site entirely comprises open ground, bound to the north, south and west by residential properties and their associated gardens, and to the east by Camplin Street. All Saint's Church is present approximately 170m south-west of the Site.
WWI	**1916**	**1:2,500**	**FIGURE 4.1:** No significant changes have occurred on Site. An unnamed school, located approximately 110m north, has been expanded.
Pre-WWII	**1938**	**1:10,560**	No significant changes have occurred on Site or in the surrounding area.
Post-WWII	**1951-1952**	**1:2,500**	**FIGURE 4.2:** A small extension to a residential structure has been built in the north-eastern extent of the Site. Multiple structural clearances are present within the study area (approximate 250m radius), located 15m west of the Site and approximately 195m north-west, 120m and 150m south, 245m south-east and 145m south-west of the Site. This is indicative of bomb damage. Two structures within the study area were labelled as 'ruins', situated approximately 45m north-east and 215m south-west. Multiple areas occupied by prefabricated properties have been identified within this mapping, located approximately 40m north-east, 145m north-west, 80m, 85m, 160m and 185m south-west. These were often constructed in areas of clearance resulting from bomb damage.

4.3 Photography/Aerial Photography

The below table describes the composition of the Site visible in WWII and post-WWII aerial photography, including areas of possible structural clearance, damage and other possible features of note. All photographs were retrieved from Historic England's (HE) Royal Air Force (RAF) Photography Archive.

Period	Photo Date	Review
WWII	18th June 1941	**FIGURES 5.1 & 5.2:** This photograph was taken during the height of the Luftwaffe bombing campaign over London. The Site appears to comprise undeveloped, open ground bound by two residential properties to the north and south. Visibility of the Site is relatively poor as the western and south-western extent of the Site is obscured by trees and the south-eastern section is obscured by shadows from the surrounding structures. Consequently, accurate analysis of potential bomb damage within the Site area has been impeded. Areas of structural clearance are visible approximately 15m west of the Site and approximately 45m north-east. Roof repairs have been identified on residential properties located approximately 25m west of the Site.
	7th August 1944	**FIGURES 5.3 & 5.4:** This low-resolution photograph was taken after the main period of bombing over Britian. The questionable quality of this photography and the previously mentioned obstructions to the visibility of the Site area means that analysis of the Site itself has been severely impeded. In the aforementioned area of structural clearance approximately 15m west of the Site, the ruined structure can be seen in its footprint. New areas of structural clearance are visible, located approximately 50m west, 80m and 105m south-east, and 155m south of the Site. Roof repairs have been identified on residential properties approximately 130m south-east of the Site.
Post-WWII	9th July 1946	**FIGURES 5.5 & 5.6:** This high-resolution photograph was taken approximately 14 months after the end of WWII in Europe. The previously mentioned obstructions to the visibility of the Site area means that analysis of the Site itself has been severely impeded. The above-mentioned areas of structural clearance within the previous photograph are still visible in this image. The development works of a new structure in the clearance 15m west of the Site can be seen. A temporary prefabricated structure is now present in the footprint of the structural clearance located approximately 45m north-east of the Site.
	28th May 1947	**FIGURES 5.7 & 5.8:** This high-resolution photograph was taken approximately two years after the end of WWII in Europe. The previously mentioned obstructions to the visibility of the Site area means that analysis of the Site itself has been severely impeded. Potential roof repairs are visible approximately 45m south-east of the Site. New structures can be seen approximately 50m west of the Site, in the footprint of a cleared structure from the image dated 1944.

4.4 Additional Site-Specific History

Some sites will have been occupied by landmarks or significant buildings historically and in such cases specific written histories including significant wartime details are occasionally available in the public domain. No such information was available.

5 UXO RISK - GERMAN BOMBING

5.1 WWI Bombing History

5.1.1 Britain during WWI

During World War I (WWI), an estimated 9,000 German bombs were dropped on London, Eastern England and South-Eastern England during some 51 Zeppelin airship raids and 52 fixed-wing aircraft raids. London suffered the worst of the bombing with an estimated 250 tonnes of HE and incendiary bombs recorded across the Capital, over half of which fell on the City of London district.

The WWI bombing campaign waged by Germany was on a far smaller scale than the WWII campaign, in terms of the number of raids, the weight of ordnance dropped during each attack and the size of the bombs used. When coupled with the fact that most WWI-bombed locations have since been redeveloped, German WWI UXB finds are extremely rare. Furthermore, most air raids took place during daylight hours and as it was the first time Britain had experienced strategic aerial bombardment, the raids often attracted public interest and even spectators, increasing the chances of any UXBs being reported.

5.1.2 Site Specific

A collection of written reports describing each air raid in the region was reviewed (I. Castle, 2024). Two air raids affected this area of Deptford during WWI.

The first air raid occurred on the night of 7th / 8th September 1915. A bomb fell on Sharratt Street, approximately 550m north-west of the Site. The next bomb was dropped on 32 Childeric Road, approximately 610m south-east of the Site.[1] It may be deduced that the flightpath of this airship did not go over the Site area.

The second air raid occurred on the evening of 25th September 1917. The first bomb to fall in the vicinity of the Site was at the Fever Hospital on Avonley Road, approximately 285m west of the Site, causing slight damage to the laundry room. The next bomb was dropped at the school on Monson Road, approximately 110m north, resulting in 'limited damage'. A bomb was dropped on a railway goods yard, approximately 245m north-east of the Site, slightly damaging one building.[2] It may be inferred that the flightpath of this airship came within proximity of the Site, at least 110m north, but crucially did not actually fly over the Site area.

Despite two WWI air raids over the wider area, WWI was the first time Britain had experienced aerial bombardment and therefore the air raids often attracted public interest and even spectators. Additionally, the relatively slow nature of an airship meant that bombs were easier to report and observed. The Site's location within a residential area would have meant it was afforded a degree of monitoring. Subsequently, no evidence has been identified to suggest the Site was affected by these raids, the associated UXO risk is considered negligible and will not be further discussed.

[1] https://www.iancastlezeppelin.co.uk/7/8-sep-1915

[2] https://www.iancastlezeppelin.co.uk/25-sep-1917

5.2 WWII Bombing History

5.2.1 London

In the summer and autumn of 1940, the Luftwaffe targeted the RAF's airfields and support network with the intention of achieving air supremacy prior to a planned amphibious invasion of south-east England. The resulting Battle of Britain campaign (July to October) resulted in many air raids across England, although these were mainly concentred in the south-east. During this period, a few small-scale raids affected the outer London boroughs.

In early September 1940, the Luftwaffe changed their tactics and commenced an indiscriminate carpet-bombing campaign against London. The resulting nine-month Blitz began on 7th September 1940 and ended on 12th May 1941 - the heaviest raid of the Blitz. The vast majority of the Luftwaffe units based in occupied Europe were then redeployed to the Russian front.

During 1943, a number of small-scale fighter bomber raids were carried out against the Capital, then in 1944, the Luftwaffe commenced Operation Steinboch. This campaign comprised 31 major raids against London and other southern England targets, executed by inexperienced Luftwaffe crews, between January and May. However, poor navigation and improved defences resulted in unsustainable Luftwaffe losses, many formations being broken up by the RAF over the Home Counties. The final large-scale Luftwaffe raid on the Capital took place during May 1944, with all air raids ceased by the end of June.

Between 1940 and 1944, there were a total of 71 major air raids on Greater London resulting in some 190,000 bombs being dropped, killing over 29,000. In total some 50,000 tonnes of HE bombs and 110,000 tonnes of incendiary bombs (mainly of the 1kg type) were dropped during the Blitz over Britain. The army BDUs successfully dealt with approximately 40,000 UXBs during the war.

Immediately following the final air raids on London, the Luftwaffe launched the V Weapons campaign, commencing in June 1944. The V1 (Flying Bomb or Doodlebug) and later the V2 (Long Range Rocket) were launched from occupied Europe. 2,419 of the former and 517 of the latter were recorded in the London Civil Defence region.

Both carried a large 1,000kg HE warhead and were constructed of thin sheet steel, rather than the thick steel used on the Luftwaffe's free fall bombs. V Weapons were designed to detonate on the surface (like parachute mines), as opposed to free fall bombs which were designed to have some penetration ability through multi-storey buildings.

Consequently, any V Weapons which failed to detonate broke up on impact, resulting in an easily identifiable debris field. Although there is a negligible risk from unexploded V Weapons on land today, they caused widespread destruction throughout London and therefore, at V Weapon impact sites, the assessment of pre-1944 UXB risk can be hampered.

5.2.2 Site Specific

Luftwaffe target photography records highlight the nearest primary target to the Site was a gas works, located approximately 885m north-west of the Site. Engineering works, located approximately 160m north-east, may have been identified as a target of opportunity.

5.2.3 Bombing Decoy Sites

In mid-1940 bombing decoys were introduced. The decoys used either:

- A system of lighting to simulate an urban area or a military airfield's runway,
- Deliberately started fires to simulate a previously bombed target,
- Dummy buildings and vehicles to simulate a military facility.

792 static decoy sites were built at 593 locations in Britain. They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. No decoys were operational within a significant radius of the Site during WWII. The closest was approximately 12km to the north-east.

5.3 WWII Bombing Records

5.3.1 Introduction

The bomb census recorded the location and type of bomb strikes to help with intelligence gathering and planning. It was compiled using information recorded by ARP wardens. These records were gathered by the Ministry of Home Security to calculate bombing density within administrative areas.

The bomb census was unreliable in the early stages of the war, though by 1941 procedures had been standardised. The quality of the census records also depended on where in the UK the records were produced. Some records are held at the National Archives and some are held at local borough archives.

Relevant records held at the National Archives and the London Metropolitan Archives were obtained for this risk assessment.

5.3.2 Bombing Density Statistics

The table below records the Ministry of Home Security's bombing density calculation for the Metropolitan Borough of Deptford. It gives a breakdown of the types of large German bombs reported and is understood to not include UXBs.

Admin Area	Deptford
Area Acreage	1,564
High Explosive Bombs (all types/weights)	717
High Explosive Parachute Mines	12
Flam (Oil) Bombs	28
40kg Phosphorus Incendiary Bombs (IBs)	18
40kg 'Fire Pot' IBs	0
V1 Flying Bomb	32
V2 Long Range Rocket	10
Total (excluding V-Weapons and 1kg / 2kg IBs)	775
Bombs Per 1,000 Acres	**495.5**

1kg / 2kg incendiary bombs and 2kg anti-personnel (AP) bombs were often too numerous to record accurately and therefore are not included in the above figures. The latter were not dropped on London. Small IBs were however dropped in vast numbers (>100,000) over the capital.

5.3.3 Bomb Census Maps

Brimstone has reviewed a collection of original consolidated and weekly bomb census maps for the wider study area. These small-scale maps cover the entire bombing campaign and record all types of bomb. Relevant maps are displayed at **FIGURE 6**.

- 36 HE bomb strikes are plotted within an approximate 250m radius of the Site, within the consolidated bomb census maps. The closest HE strike is plotted approximately 15m west of the Site.
- One incendiary shower is recorded within the above-mentioned radius of the Site, within the weekly bomb census mapping.
- Six potential bomb-sticks have been identified within the weekly bomb census mapping. The closest HE strike within a bomb-stick was plotted approximately 40m west of the Site, therefore it is possible an unexploded bomb dropped within this flightpath may have fallen within the Site boundary.
- No day-time air raids affected the study area.
- One 1kg / 2kg IB shower is plotted over the Site boundary. NB: no weekly plot maps are available for the 7th September to 7th October 1940 period and therefore it is not known whether IB showers affected the Site during this month.

5.3.4 V Weapons

Brimstone has reviewed a collection of original consolidated V1 Bomb Plot Maps, as well as a contemporary plot map of V2 Rocket incidents, produced using collections of original written incident reports.

No V1 or V2 strikes are plotted within or adjacent to the Site boundary. The closest V1 strike (7th July 1944) is plotted approximately 265m to the north-east, this can be seen at **FIGURE 7.** The closest V2 strike (25th November 1944) occurred 610m to the west.

Whilst a V1 strike is plotted approximately 265m north-east of the Site, several blocks of buildings that survived the conflict externally intact will have shielded the Site from the 1,000kg HE blast. Therefore, this incident is considered insignificant.

5.3.5 Bomb Damage Map

Brimstone has reviewed an original war damage map covering the study area. The map was produced by the Engineer and Surveyors Department of the London County Council and was updated throughout the bombing campaign. A section of the map covering the study area is displayed at **FIGURE 8**.

- This source only records damage to structures, therefore as there were no structures on Site during WWII, any potential damage within the Site area would not be recorded.
- However, most of the structures within the study area (approximate 250m radius) are recorded as sustaining varying levels of damage.
    - The structures bordering the Site to the north and south were coloured yellow, indicative of ‘blast damage – minor in nature’ which corroborates post-WWII imagery that confirms these structures survived the war structurally intact.
    - The closest structure coloured black, indicating ‘total destruction’ was located approximately 15m west of the Site, this can be confirmed in WWII-era and post-WWII aerial photography where this structure has been cleared. This also corresponds to a HE bomb strike recorded within the London bomb census mapping.
- Overall, the damage recorded within the LCC damage map generally corroborates post-WWII aerial photography and OS mapping. Structural clearance is present in the areas within the latter two sources, where structures are recorded as sustaining more severe damage in the LCC damage map.

5.3.6 Abandoned Bomb Register

Due to the overstretched bomb disposal units during WWII, many bombs were intentionally left undisturbed. UXBs were triaged based on where they were and how big they were. If they didn't pose a significant risk, they were 'abandoned'. The locations of these bombs were recorded on the abandoned bomb register.

The abandoned bomb register is a public record document held at the Parliamentary Archives of the House of Commons, from which Brimstone has obtained a copy. The register should not be relied on for completeness or accuracy. The closest abandoned bomb is recorded approximately 1.3km south-west of the Site.

5.3.7 Secondary Source / Anecdotal Evidence

A search of online resources, as well as a review of local history publications was carried out with the intention of locating any eyewitness accounts of local bombing incidents. However, no such evidence was found.

5.4 Likelihood of UXB Contamination

Where detailed bombing records exist, it is possible to predict whether any UXBs could be found on a site. This likelihood is discussed in the following table:

Density of Bombing	
Number of Air Raids in the Vicinity:	A comparison of the bombing incident records confirms that at least five air raids affected the study area. NB: this number was almost certainly higher as east London was bombed many times during the first month of the Blitz, for which weekly plot maps are unavailable.
Intensity of these Air Raids:	All bombs dropped locally were likely part of medium or large-scale indiscriminate carpet-bombing raids, all of which were carried out at night.
Bomb Strike Positions	
Closest Bomb Strikes	HE bombs: 15m west. 1kg / 2kg IBs: On Site.
Alignment of recorded Bomb Strikes:	For districts with a very high bombing density, such as that within which the Site was situated, accurate analysis for the alignment of bomb strikes is not always possible. However, six potential bomb sticks have been identified; it must be noted that identified bomb sticks do not appear to straddle the Site. However, one is recorded as dropping a HE bomb approximately 40m west of the Site, as this is within close proximity of the Site, it is possible an unexploded bomb falling from this plane may have landed on Site. Also, as it has not been possible to identify the majority bomb sticks over the Site, there may have been multiple occasions during which a UXB (unobserved and unplotted) could have been released over and landed within the Site boundary. For most small IB spreads (covering a wide area) it is impossible to correctly identify the aircraft's flightpath and thus bomb-stick alignment. Furthermore, such bombs were significantly affected by the wind, further hampering analysis.
Bomb Failure Rate	
Evidence to suggest that the generally accepted failure rate of 10% differs in the vicinity of the Site:	None.
UXBs recorded in close proximity to the Site:	Closest plotted UXB strike to the Site was an unexploded oil bomb located approximately 245m south-west.

5.5 Likelihood of Subsequent UXB Detection

A range of circumstances determine whether a UXB strike location would have been identified, during and after the war. This is discussed in the following table. This includes level of access to the Site during WWII, bomb damage, as well as the ground cover during WWII. This is discussed in the following tables.

Historic Access
A UXB falling on a site which was frequently accessed would have had a better chance of being found. ARP Wardens actively searched for UXBs in heavily bombed residential areas. The importance of a site or nearby buildings and infrastructure was also a factor. Many industrial facilities had fire watchers tasked with extinguishing incendiary bombs and reporting UXBs.
As a majority air raids in the immediate vicinity occurred during the hours of darkness, there is a greater probability that any UXB strike to the Site could have occurred unobserved as residents / employees were inside. Furthermore, no evidence of fire watchers providing night-time observation in the vicinity was found. These factors decrease the likelihood that any UXB fall would have been witnessed and reported. As the Site comprised open ground bordered by residential structures it may have received intermittent access levels throughout WWII, which may have provided an opportunity for a potential UXB strike to be noticed and reported. That being said, damage is recorded adjacent in all directions of the Site, as a result, the associated properties may have been evacuated for a period of time while repairs were conducted which would drastically reduce access levels to the Site for a period of time. This would increase the probability of a UXB strike going unnoticed and unreported.

Bomb Damage
As the bombing campaign continued, damaged areas became vulnerable to unreported UXBs. Bomb site wreckage or soil disturbance at a bomb crater could obscure evidence of a subsequent UXB strike.
As the Site comprised undeveloped, open ground between residential structures, the visibility of the Site within available imagery has been obstructed by dense vegetation and the surrounding structures' shadows. However, extensive bomb damage is visible in the study area within both WWII-era and post-WWII aerial photography, London County Council (LCC) Bomb Damage mapping and post-war OS mapping. Cleared structures are visible approximately 15m and 50m west, 45m north-east, 80m and 105m south-east and 155m south of the Site; see **FIGURE 5.4**. In addition to this, roof repairs to residential properties have been identified within aerial photography approximately 25m west and 45m south-east of the Site, see **FIGURES 5.2** & **5.8**. 1951-1952 OS mapping confirms the aforementioned clearances as well as showing that multiple cleared areas were subsequently used for prefabricated properties. London County Council (LCC) Bomb Damage mapping records the structures which border the Site to the north and south as sustaining 'blast damage – minor in nature'. Most of the structures in the vicinity are recorded as sustaining varying levels of damage, including the structure 15m east of the Site as coloured black indicating it was totally destroyed. This is confirmed in the above-mentioned aerial imagery and post-war OS mapping.

Ground Cover Type
A UXB which falls on open field could easily go unnoticed, whereas a UXB dropped on a hard-surfaced car park would have been easily observed.
Within WWII-era aerial photography Site appears to have comprised undeveloped, open ground with mature vegetation present in the western and south-western extent of the Site. Such ground cover could present conditions unconducive to the visual detection of UXBs, i.e., overgrown and unmaintained vegetation. Visual evidence of a UXB strike, such as a small entry hole, could have easily become obscured within such conditions. Indeed, the smallest German HE bomb (50kg), also the most commonly deployed over Britain during WWII was just 20cm in diameter; a UXB strike could therefore leave a small, easily obscured entry hole.

6 WWII GERMAN BOMBS

6.1 Bombs Dropped on the UK

Nazi Germany used different types of ordnance against the UK for different effects. Some types were designed to cause fires, others for their destructive blast effect and other for their penetration capability. Each type of ordnance was fitted with at least one fuze. For some bombs multiple fuzes were used. Many different types of fuzes were available for use – each with its own set of associated hazards.

Data sheets on those bombs most likely to be encountered today are included at **APPENDIX 2**.

- **HE bombs – moderate NEQ (net explosive quantity):** the most common types of HE bombs dropped were the SC (general purpose - GP) and SD (semi-armour piercing - SAP) series of bombs. The NEQ is between 30-50%. SAP bombs are engineered to attack light fortifications, whereas GP bombs are used in a mixed destructive blast and anti-personnel fragmentation role. 70% of bombs dropped on the UK were the 50kg type.
- **HE bombs – high NEQ:** blast bombs and parachute mines have bodies made of thin steel, allowing for larger HE charges. These were designed to detonate above ground, maximising the blast effect. Parachute mines were weapons slowed by parachutes and designed to detonate without penetrating the ground. Although, in some marshland areas, partially buried parachute mines have been observed. Consequently, it is highly unlikely that any unexploded blast bombs remain buried in the UK today.
- **HE bombs – low NEQ:** The PC series were armour piercing bombs used against heavy fortifications and reinforced bunkers. They were not commonly used over the UK.
- **Small incendiary bombs:** The 1kg and 2kg incendiaries were the most dropped bomb. Up to 620 x 1kg incendiaries could be packed into the largest container unit, which opened at a pre-determined height scattering its payload over a wide area. These small bombs could fully penetrate soft ground due to their small diameter. Variants of the 1kg and 2kg incendiary bombs contained a small HE charge designed for an anti-personnel role, and to increase its incendiary effect.
- **Large incendiary bombs - Thick skinned:** The C50 has a thick body and contained a mixture of incendiary liquids and white phosphorus. Another version of the C50 had a white phosphorus fill. The C50 'firepot' contained thermite incendiary containers (aka firepots) and a small HE charge.
- **Large incendiary bombs - Thin skinned:** The Flam 250 and Flam 500 models had thin steel bodies designed to break up on impact, spreading their oil-incendiary mixture, which was ignited by a small HE charge. Consequently, it is highly unlikely that any unexploded Flam bombs remain buried in the UK today. Their unreliability meant withdrawal from frontline use by January 1941.

- **Submunitions:** The SD2 'butterfly' bomb was a 2kg submunition dropped on several British cities and towns. It contained a 225gram HE charge. SD2s had no ground penetration ability so the vast majority were recovered at the time. However, SD2s are still found across Britain today.
- **V1 flying bombs and V2 rockets:** In the final year of WWII Germany began using pilotless weapons against England. Both V Weapons had 1,000kg HE warheads. Due to their light-body construction, they had no penetration ability, and any impact left a noticeable debris field. As such, there is negligible risk from unexploded V Weapons today.

6.2 Bomb Failures

Records from September 1940 to July 1941 show that an average of 84 UXBs were dropped on civilian targets each day. Around 8% of these were time delay bombs – designed to strike the ground and start a predetermined countdown which could last days.

There is a generally accepted 10% failure rate for WWII German HE bombs. This is estimated from records gathered by bomb disposal units. These statistics do not account for UXBs that went by unnoticed.

Failures can happen for different reasons, including:

- Equipment or human error in arming the bombs before release,
- Failure of a mechanism within the fuze (out of tolerance),
- Jettisoning payloads if the bomber was under attack or crashing, or
- Partially functioned bombs (e.g. cracks in the cast TNT).

6.3 Bomb Ground Penetration

6.3.1 Introduction

Using data gathered during WWII by the Ministry of Home Security, estimations can be made about how deep a bomb is likely to penetrate the ground. Over one thousand incidents were reported by the bomb disposal units to support this research. Further tests were carried out, dropping bombs of different sizes into chalk and measuring the depths they reached. This research is held at the National Archives. The estimates are:

Bomb weight (kg)	Ground Type (m)									
	Sand		Gravel		Chalk		Clay		Sandstone	
	Average	Max.	Average	Max.	Average	Max.	Average	Max.	Average	Max.
50	2.8	7.8	2.8	7.8	3.5	7.7	4.0	9.1	2.7	6.0
250	4.8	13.7	4.8	13.7	6.0	13.1	6.8	15.8	4.6	10.4
500	6.0	17.3	6.0	17.3	7.6	16.4	8.7	19.8	5.8	13.1
1,000	7.6	21.9	7.6	21.9	9.6	20.7	10.9	24.9	7.3	16.5

Different layers of geology affect penetration depths. For example, 1m of made ground, then 1m of gravel before reaching clay – as is many areas of London – is not easily calculated from the data above.

When calculating how deep a bomb could have reached, we must make three assumptions:

- **Impact velocity:** German bombing raids were carried out at altitudes in excess of 5,000m. The velocity of impact is roughly 313ms^{-1} (not accounting for resistance). It is the same velocity regardless of mass.
- **Impact angle:** strike angles of 10 to 15 degrees to the vertical. It must be assumed that the bomb was stable at the moment of ground penetration.

- **Bomb design:** Some larger German bombs were occasionally fitted with 'kopfrings' - a metal ring, triangular in cross section, fitted around the nose of the bomb to help prevent penetration. It must be assumed that no 'kopfrings' were fitted.

6.3.2 The J-Curve Effect

During WWII, Bomb Disposal Units (BDUs) reported that most buried UXBs were found horizontal or upturned. This observation confirmed the 'J-curve effect'. As an HE bomb penetrates the ground, slightly offset from the vertical, its passage underground creates a 'J' shape.

This is relevant because the J-curve effect results in a horizontal offset between the buried UXB and its point of entry. This distance is estimated to be one third of the theoretical penetration depth. A low altitude attack, meaning a low impact angle, could produce an even greater offset, of up to 15m.

6.3.3 Site Specific Geology

BGS Mapping	**Superficial Deposits:** Langley Silt Member - Clay and silt	**Bedrock Deposits:** Thanet Formation - Sand
SI Data	No recent SI data was provided by the Client. However, local BGS borehole logs were available. The closest BGS SI through the same mapped geology as the Site is located approximately 215m south-west of the Site (BGS ID: 15624051). This SI (August 1987) encountered the following ground conditions: - 0.3m of made ground – tarmac, sand and bricks. - 1.2m of made ground – firm brown clay with bricks. - 4.4m of dense sand and gravel. - 3m of fine sand with layers of silty sandy clay. - 1.7m of hard chalk and flints.	

6.3.4 Site Specific Maximum Bomb Penetration Depth

During WWII, the Luftwaffe dropped many different types of HE bomb. The SC (general purpose) series was by far the most numerous and of this series, the SC 500 model (weighing 500kg) was the largest of the most commonly deployed and therefore this will be used as the benchmark weapon for the Site-specific bomb penetration depth calculations.

In order to calculate the most likely maximum depth to which a bomb would penetrate, Brimstone has taken the average of the average and maximum figures for the predominant Site-specific geology (clay, sand and gravel) in the table above. This gives a likely maximum bomb penetration depth of 12.5m below WWII ground level for a 500kg bomb.

Note, the Ministry of Home Security data indicates that the maximum bomb penetration depth could be down to 19.8m for a 500kg bomb, or 24.9m for a 1,000kg bomb; however, in line with the ALARP principle, it is not considered to be a likely scenario that a bomb would penetrate so deeply. Furthermore, while evidence indicates that a 1800kg HE bomb could penetrate to over 30m, these types of bombs were not dropped frequently. For example, War Office statistics confirm that between October 1940 and May 1941 the majority of HE UXBs (>90%) were either 50kg or 250kg, with the 500kg bombs making up most of the remaining 10%.

7 UXO RISK - BRITISH/ALLIED ACTIVITY

7.1 Introduction

The table below lists potential sources of UXO (excluding enemy action). Those which are potentially relevant to the Site are discussed in the subsequent section(s).

Potential UXO Source	Potentially Significant
Army or RAF training areas / ranges	×
Military bases and other installations	×
Munitions and explosives factories	×
Military storage depots	×
Defensive fortifications	×
Wartime site requisitions	×
WWII defensive mining (landmines)	×
WWII Home Guard activity	×
Wartime anti-aircraft fire	✓

7.2 Potential Sources of UXO

7.2.1 Introduction

Research has not located any evidence of significant British or Allied army, RAF or Royal Navy activity specifically on Site and none is likely to have occurred historically. The only likely potential source of British UXO contamination is therefore WWII AA artillery fire.

7.2.2 WWII Anti-Aircraft Fire

Anti-Aircraft (AA) Command was a British Army command established in 1939 to defend the UK during the anticipated German bombing campaign. It controlled the Territorial Army AA artillery and searchlight units. From 1940 to 1945 BDUs dealt with 7,000 unexploded AA shells in Britain. There were three main types of AA battery used for home defence (see below). Data sheets on these AA defences are included at **APPENDIX 3**.

- **Heavy Anti-Aircraft (HAA):** large-calibre guns (3.7" and 4.5") for engaging high-altitude bomber formations. Hundreds of permanent batteries were constructed in and around major cities and military bases during the 1930s. Some 2,000 of these guns were available during the Blitz. Each gun could fire between 10 and 20 rounds per minute and consequently HAA batteries could expend large quantities of shells during each engagement.

  British time fuses were poorly manufactured during WWII, and this led to high failure rate for HAA shells, up to 30%. Unexploded HAA shells had the potential to land up to 27km from their battery, although more typically landed within a 15km radius.

- **Light Anti-Aircraft (LAA):** smaller calibre guns for engaging dive bombers and low altitude intruders. As such, they were mostly used to defend specific industrial and military targets which were subject to precision bomber attack. LAA guns were either .303" calibre machine guns or 20mm and 40mm calibre cannon. The latter were fitted with simply impact fuses and small incendiary or HE bursting charges.

  The 40mm Bofors gun could fire 120 x HE shells / minute to a ceiling of 1,800m. Each shell was designed

to self-destruct if it didn't strike an aircraft, however, inevitably some failed and fell back to earth.

- **Z (Rocket) Batteries**: a Z-Battery comprised a grid formation of 64 rocket projectors which fired 2" and later 3" Unrotated Projectile (UP) rockets to a maximum altitude of 5,800m; a ground range of some 9,000m. They were deployed in cities all around the UK from 1941 and proved to be an effective addition to the existing AA guns.

  The rockets measured 0.9m (2") and 1.8m (3") in length with four stabilising fins at the base and were fitted with 3.5kg or 8.2kg HE warheads. The larger warhead had an effective airborne blast radius of up to 20m. Some variants deployed a form of aerial mine described as a "small yellow bomb" which was designed to detach from the rocket at height and descend on a parachute with the objective of becoming snagged on target aircraft and then detonating.

Unlike bombs which were designed to strike the ground, AA projectiles and rockets were designed to function in the air. Due to their shape, and centre of gravity they would often not strike the ground nose first. This coupled with the lower mass of AA UXO resulted in shallower ground penetration depths, compared to UXBs. Although, in very soft conditions, unexploded AA projectiles have been found deeper than 1.5m bgl.

41 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was frequent and intense over the wider area and therefore these guns would have expended a vast quantity of ammunition. Consequently, there is an elevated likelihood of unexploded AA shells striking the Site.

8 UXO RISK MITIGATING CIRCUMSTANCES

8.1 Introduction

Works on a UXO contaminated site could result in the partial or complete removal of UXO risk. Construction or earthworks may have uncovered any UXO contamination, which would then have been reported and removed by the authorities. A site may have been subject to an explosive ordnance clearance (EOC) task conducted by the armed forces. EOC tasks involve surveying, subsequent target investigation and removal of UXO. Although the effectiveness of historic EOC tasks will have often been unsatisfactory.

8.2 Explosive Ordnance Clearance Tasks

The division of EOC tasks has been complex throughout British military history. It used to be the case that anything under the water level would be dealt with by navy units, and anything on land would be dealt with by army units. In recent years, RAF Explosive Ordnance Disposal (EOD) capability has been discontinued, and now only the Royal Navy and the British Army have EOD units. In the army, the Royal Logistics Corps and Royal Engineer EOD units have been amalgamated to form 29 EOD & Search Group. Often taskings are assigned to either the naval or army elements based on where in the country the threat is and the nature of the threat.

Brimstone has access to a database of historic EOC tasks. This database is only complete up until the early 2000s and therefore does not include recent EOC tasks. No such database for the RAF and Royal Navy EOD units is easily accessible. An EOC task has been identified at Fordham Park, Pagnell Street, approximately 480m south-east of the Site. The task occurred in January 1981; no items of ordnance were discovered during this task.

UXO encounters on civilian land are often reported in the media and therefore a web search of local media outlets was also carried out. No recent incidents within close proximity to the Site were identified.

8.3 Ground Works

Minimal post-WWII works have been conducted on Site. The construction of the small structure in the north-eastern section of the Site and its subsequent clearance likely involved excavations which partially intruded into shallow (1-2m bgl) depths. The laying of hardstanding post-conflict would have disturbed WWII-era soil to very shallow (<1m bgl) depths.

8.4 Deductions

The risk associated with any very shallow buried UXO will have been largely mitigated across the majority of the Site, in the footprint of post-war hardstanding. The risk associated with any shallow buried UXO may be partially mitigated in the footprint of the post-WWII structure in the north-eastern extent of the Site. The risk associated with any deep (>2m bgl) buried UXO almost certainly remains unmitigated.

Please note, the risk of a UXO encounter can be considered mitigated in the exact locations and down to the exact depths of any post-WWII intrusive works.

9 CONCLUSION

9.1 Accuracy of Historical Records

Occasionally, the accuracy of some historical records can prove to be poor when compared with other sources of information. One significant consequence of this can be the possibility of unrecorded German bomb strikes in the study area. No such inconsistencies were noted within the records consulted for this report.

9.2 The Risk of UXO Contamination on Site

9.2.1 Key Findings – German UXO Risk

- London was the most frequently and heavily bombed British city during WWII. Indeed, the Site was located within the Metropolitan Borough of Deptford, which sustained 495.5 bombs / 1,000 acres, a very high bombing density according to the official Home Office bombing statistics. The nearest primary target identified by the Luftwaffe was a gas works approximately 885m north-west of the Site. An engineering works, located approximately 160m north-east, may have been identified as a target of opportunity.
- The Site's situation in a borough with a very high bombing density is evident in the London bomb census mapping, which records one incendiary shower over the Site area and a further 36 HE bomb strikes within an approximate 250m radius of the Site. The closest HE strike is plotted approximately 15m west of the Site.
- The damage likely resulting from this bomb strike is documented within the London County Council (LCC) bomb damage mapping, the structures immediately north and south of the Site were coloured yellow, indicating they sustained 'blast damage – minor in nature' and the structure 15m west of the Site is recorded as being totally destroyed, which aligns with the plotting of the HE bomb strike. It should be noted that the majority of the structures within the study area (approximate 250m radius) are recorded as sustaining varying degrees of damage, resulting from the very high local bombing density.
- Both WWII-era and post-WWII aerial photography corroborate this damage, displaying areas of structural clearance located approximately 15m and 50m west, 45m north-east, 80m and 105m south-east and 155m south of the Site (see **FIGURE 5.4**). Additionally, multiple residential structures have been identified as undergoing roof repairs, located approximately 25m west and 45m south-east of the Site, in photography dated 1941 and 1947.
- Wartime access levels to the Site are anticipated to have been intermittent during the war, due to its proximity and likely association with the adjacent residential properties. However, the blast damage sustained to these properties may have resulted in a temporary evacuation while repairs were conducted, which would have drastically decreased access levels. It is possible during this period that a UXB strike occurred unnoticed and unreported.

- From analysis of WWII-era photography, it appears the Site comprised undeveloped, open ground with mature vegetation present in the western and south-western extents of the Site. This will have likely created conditions where evidence of UXB strike could become obscured and remain undetected. Moreover, the Site was bound to the north, south and west by associated gardens of residential properties, where ground cover conditions were likely unconducive to the detection of UXBs. This means the Site was vulnerable to the J-Curve Effect, wherein a UXB may travel laterally from its point of penetration and come to rest in a different location (see ***Section 6.3.2***).
- In conclusion, the Site was located in a London Borough which suffered heavy German bombardment. The Site is recorded as suffering an incendiary bombing incident, whilst it cannot be ascertained whether the Site sustained bomb damage due to the limitations of the available sources, it is evident the immediate surrounds of the Site were severely affected by German bombing. In addition, conditions on Site were unconducive to the visual detection of UXBs, and minimal post-war redevelopment appears to have occurred on Site, therefore any potential German UXB may remain in situ. Consequently, the Site has been assessed as **Moderate Risk** from German UXO contamination.

9.2.2 Key Findings - British UXO Risk

- No evidence of historic military activity within the Site boundary has been found and it is highly unlikely that any has occurred historically, owing to the Site's situation with a residential area. Consequently, the risk from associated UXO is **Low.**
- Numerous (>40) permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was frequent and intense over the wider area and therefore these would have expended a vast quantity of ammunition. The risk of encountering this type of UXO is considered analogous with that of German UXBs and has subsequently been assessed as **Moderate Risk.**

9.3 Site-Specific UXO Hazards

Different types of UXO pose differing types of hazard, depending on their structural design, Net Explosive Quantity (NEQ), fill type and likely contamination depth. The table below lists the main types of UXO most often encountered on urban UK sites and their relative hazard levels.

UXO Type	NEQ (NEQ Range)	Likely Burial Depth	Hazard Posed
WWII German General Purpose HE Bombs	25kg - 220kg (most commonly deployed bomb weights)	Deep burial (>2m)	**HIGH**
WWII British Heavy Anti-Aircraft Shells (HAA Shells)	1.1kg - 1.7kg	Shallow burial (1-2m)	**MODERATE-HIGH**
WWII British Land Service Ammunition (LSA)	<2kg	Shallow burial (1-2m)	
WWII German 2kg Incendiary / HE Bombs (IBs)	680g incendiary hazard + ~500g explosive hazard	Shallow burial (1-2m)	
WWII German 1kg IBs	680g (incendiary, not explosive hazard)	Shallow burial (1-2m)	**MODERATE**
WWII British Light Anti-Aircraft Shells (LAA Shells)	4g - 70g	Very shallow burial (<1m)	**LOW-MODERATE**
Small Arms Ammunition (SAA)	<1g	Very shallow burial (<1m)	**LOW**
Inert/Practice Item	0g	Very shallow burial (<1m)	

9.4 The Likelihood of UXO Encounter

9.4.1 Introduction

This report assesses the risk of UXO in relation to the proposed works, not simply the risk that UXO remains buried on Site. The likelihood of UXO encounter during intrusive ground works will vary depending on the type of UXO and the type of construction methods employed during the project. With increased soil disturbance i.e. more excavations, the likelihood of encountering UXO increases.

Within an area of elevated UXO contamination likelihood, the sub-surface volume of potential UXO contamination will comprise the natural soil / geology in between WWII ground level and the maximum bomb penetration depth. Therefore, any intrusions into this layer will be at risk of UXO encounter.

Any post-WWII fill material deposited on a site is unlikely to be contaminated with UXO and therefore the risk of encountering UXO on such a site could vary with depth.

In the wake of the initial nine-month Blitz, many cities and towns were left with vast quantities of bomb site rubble that required removal and relocation. This material was put to use for in a variety of ways, for example >750,000 tons of London's rubble was used to build runways for new RAF and USAAF airfields and much of Liverpool's rubble was used to create and maintain sea / flood defences throughout Merseyside.

It is quite possible that unexploded British AA projectiles and German 1kg incendiaries were overlooked during removal, resulting in UXO contaminated fill material ending up on otherwise low UXO risk sites, possibly many miles from any high bombing density areas.

9.4.2 German UXBs

Although most German UXBs came to rest several metres below WWII ground level, these weapons can be found at any level between just below WWII ground level and the maximum bomb penetration depth. There are a number of reasons why these heavy bombs might be found at surprisingly shallow depths.

- **Tip and run:** When enemy aircraft had to take evasive action to escape RAF fighter intercepts or AA defences, they often dropped their bomb loads from a reduced height, potentially resulting in extreme J-curve effect.
- **Deflection:** the shape of German bomb nose sections meant they were susceptible to deflection when striking surface or shallow sub-surface obstacles, occasionally resulting in shallow burial or even UXBs skidding across hardstanding.
- **Aircraft Crash Site:** if an aircraft was unable to dump its bomb load before impacting the ground, due to mechanical fault, any externally fitted bombs could have become buried on impact.

German 1kg / 2kg incendiaries were cylindrical and approximately 50mm in diameter. They had tail sections, and so landed nose first. Within soft ground this could result in full penetration of the bomb below the surface. Such UXBs are usually found close to the surface.

9.4.3 British / Allied UXO

The nature of British/Allied military activity involving LSA and SAA and the smaller size of these munitions (in relation to German HE bombs) indicates that any resulting UXO contamination on a site will be limited to shallow depths, usually within 1.5m of the surface, notwithstanding added material to raise the ground level.

Domestic military LSA and SAA contamination will either be the result of expending blinds (dud ammunition) which bury into the ground on impact or munitions purposefully buried, for a number of reasons. Either way, these types of UXO are all found at shallow depth.

9.4.4 Deductions

An elevated likelihood of UXO contamination (German) and likelihood of that UXO remaining up to the present day has been identified across the entire Site. Therefore, all the proposed works are considered to be exposed to a UXO encounter.

10 OVERALL RISK RATING

Ratings for the likelihood of UXO contaminating the Site, remaining within the Site up to the present day and being encountered during the proposed works, inform the overall risk rating. Please refer to the UXO hazard table presented in ***Section 9.3*** for a breakdown of the most common hazards and their associated risk. The colour of each respective type of hazard indicates the associated risk, as defined within the aforementioned table. The UXO risk to the proposed works has been assessed as **MODERATE.**

Risk Table					
Risk Zone	**UXO Type (Hazard)**	**Likelihood of UXO Contamination**	**Likelihood of UXO Remaining**	**Likelihood of UXO Encounter**	**Overall Risk Rating**
Moderate	**WWII German GP HE Bombs**	Moderate	Moderate-High	Moderate	**MODERATE**
	HAA Shells	Moderate	Moderate	Moderate-High	
	LSA	Low	n/a		**LOW**
	German 2kg IBs	Low	n/a		
	German 1kg IBs	Low	n/a		
	LAA Shells	Low	n/a		
	SAA	Low	n/a		

11 RISK MITIGATION RECOMMENDATIONS

Brimstone has identified an elevated UXO risk to the proposed works. The measures detailed below are recommended to mitigate the risk to ALARP level.

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings: To all personnel conducting intrusive works on Site. An essential part of the Health & Safety Plan for a site. Conforms to the requirements of CDM2015.	Prior to all intrusive works commencing.
EOD Engineer - On Site Supervision: Watching brief for open excavations below WWII ground level. Portable magnetometer instruments for clearing ground ahead of borehole positions and shallow excavations (where / when appropriate). Positive identification of suspicious (non UXO) objects. Liaison during confirmed UXO incidents. Provision of additional UXO Safety Awareness Briefings.	Watching brief of all open excavations and magnetometer survey of borehole locations.
Intrusive Magnetometer Probe Survey: A range of intrusive magnetometer methodologies can be deployed to survey the ground (down to the maximum bomb penetration depth) prior to deep intrusive works; pile foundations. The appropriate technique is governed by a number of factors, the most important being the site-specific ground conditions.	Of all/any pile positions.

FIGURES: 1 - 8

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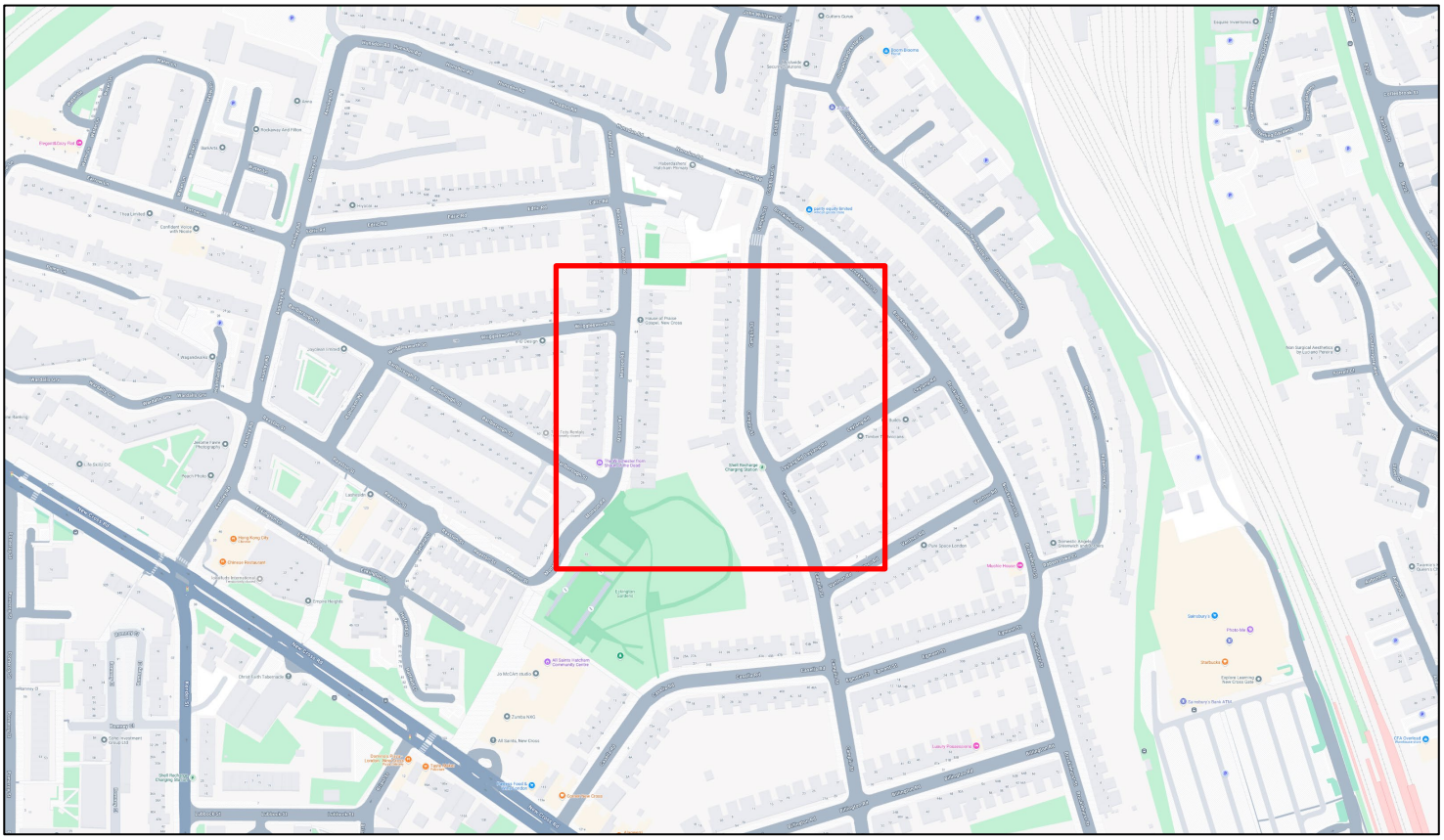
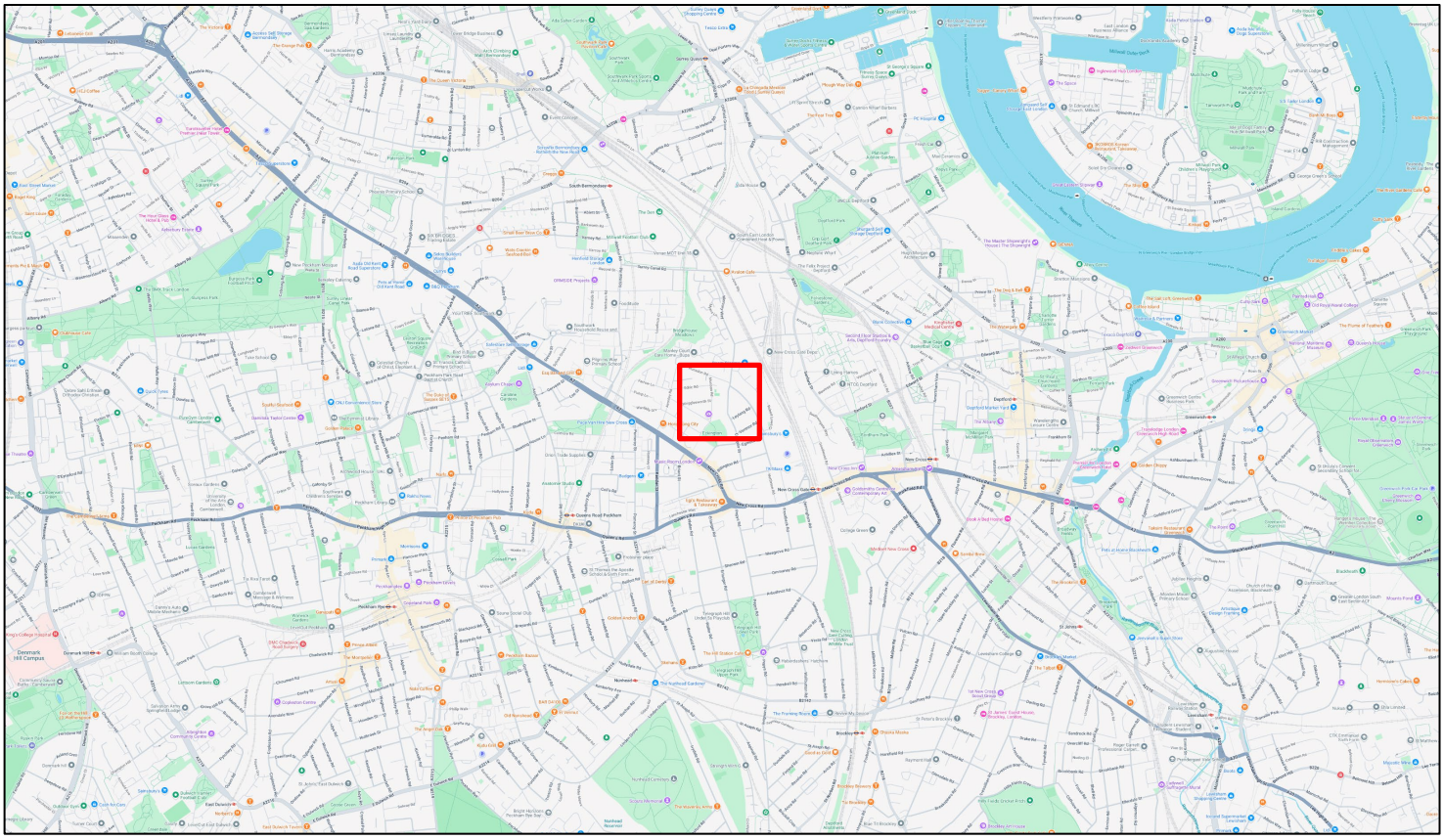
N	Title:	Site Location Maps	FIGURE: 1





Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
General Site Location:	Info Source: Google (open-source)

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N	**Title:**	**Recent Satellite Imagery**	**FIGURE: 2**

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Google (open-source)

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N	**Title:**	**Existing Site Plan**	**FIGURE: 3**

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Site Boundary:	Info Source: Lewisham Council)

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Title:	**Historical OS Mapping - 1916**	**FIGURE: 4.1**

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Landmark Maps

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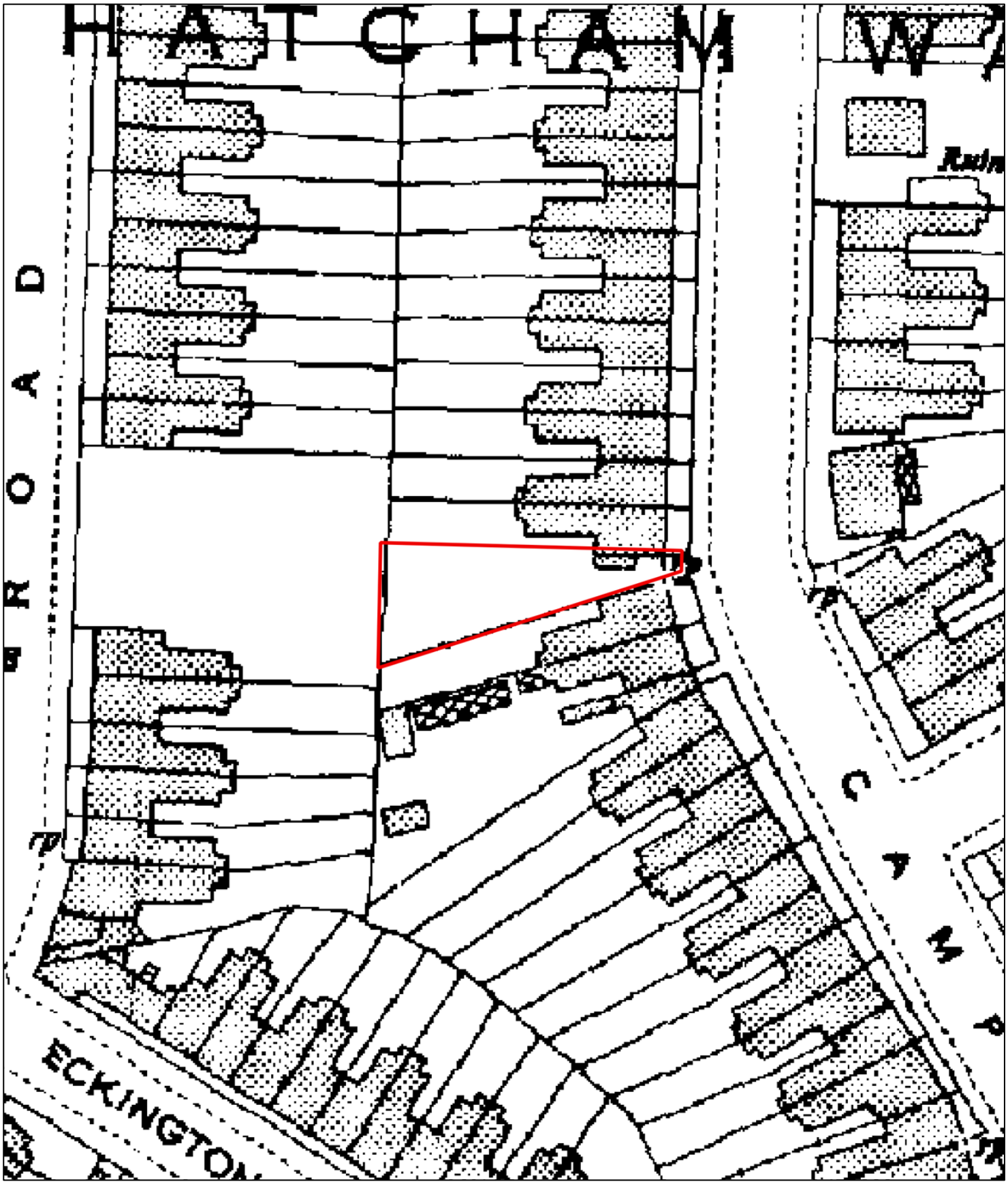
N	**Title:**	**Historical OS Mapping – 1951-1952**



Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Landmark Maps

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FIGURE: 4.2

N	**Title:**	**Historical Aerial Photography – 18th June 1941**	**FIGURE: 5.1**

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N	Title:	Historical Aerial Photography – 18th June 1941	FIGURE: 5.2

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N

Title: Historical Aerial Photography - 7th August 1944

FIGURE: 5.3

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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Title:	Historical Aerial Photography - 7th August 1944	FIGURE: 5.4

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N	**Title:**	**Historical Aerial Photography – 9th July 1946**	**FIGURE: 5.5**

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N	**Title:**	**Historical Aerial Photography – 9th July 1946**

FIGURE: 5.6

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N	**Title:**	**Historical Aerial Photography – 28th May 1947**

FIGURE: 5.7

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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N	**Title:**	**Historical Aerial Photography – 28th May 1947**

FIGURE: 5.8

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: Historic England

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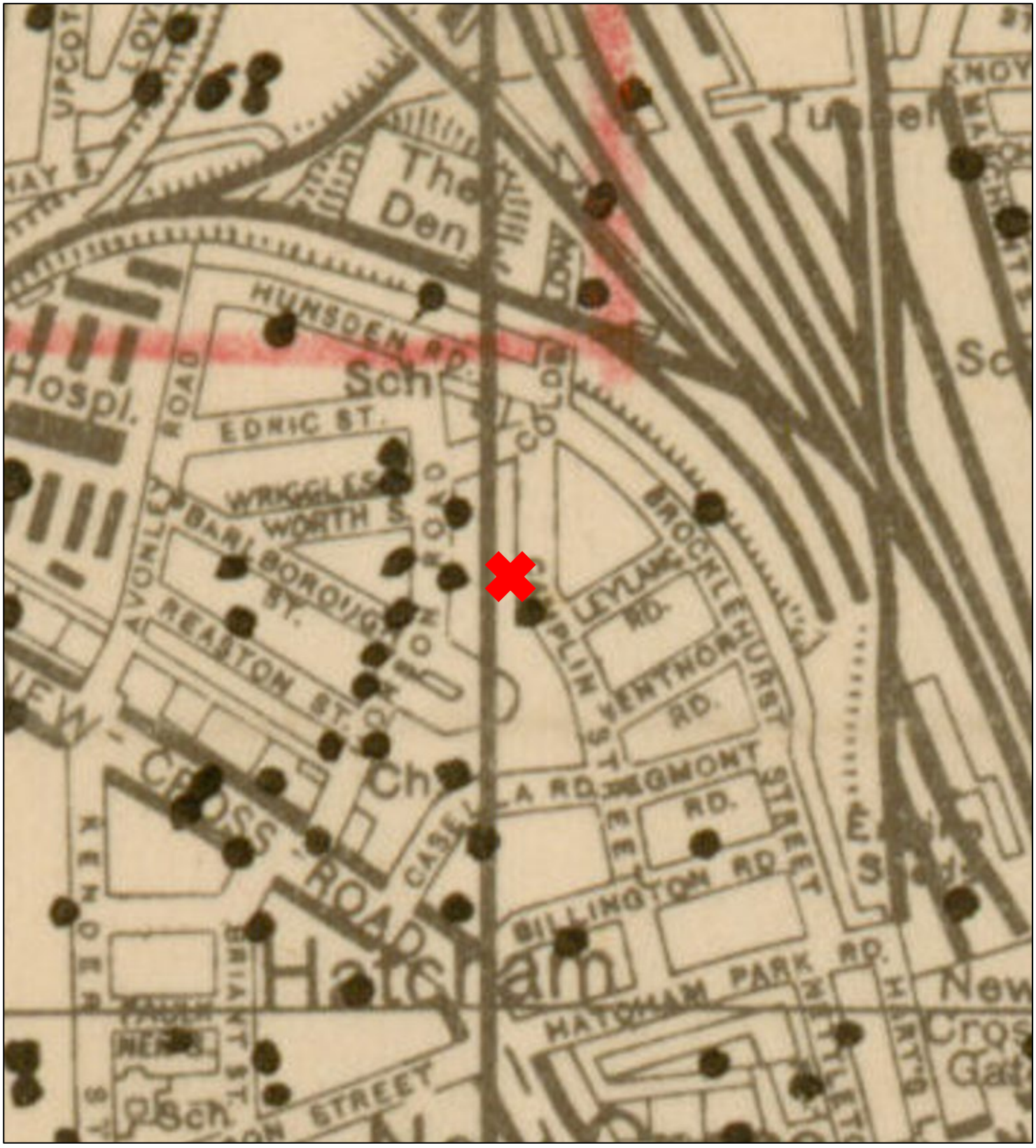
N	**Title:** Consolidated Bomb Census Mapping – Up to 07/10/1940	**FIGURE: 6.1**



● 'Iron' bomb

● Parachute Mine

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Location: ✖	Info Source: The National Archives

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N	**Title:** Consolidated Bomb Census Mapping – 07/10/1940 – 28/07/1941	**FIGURE: 6.2**

● 'Iron' bomb

● Parachute Mine

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Location: ✖	Info Source: The National Archives

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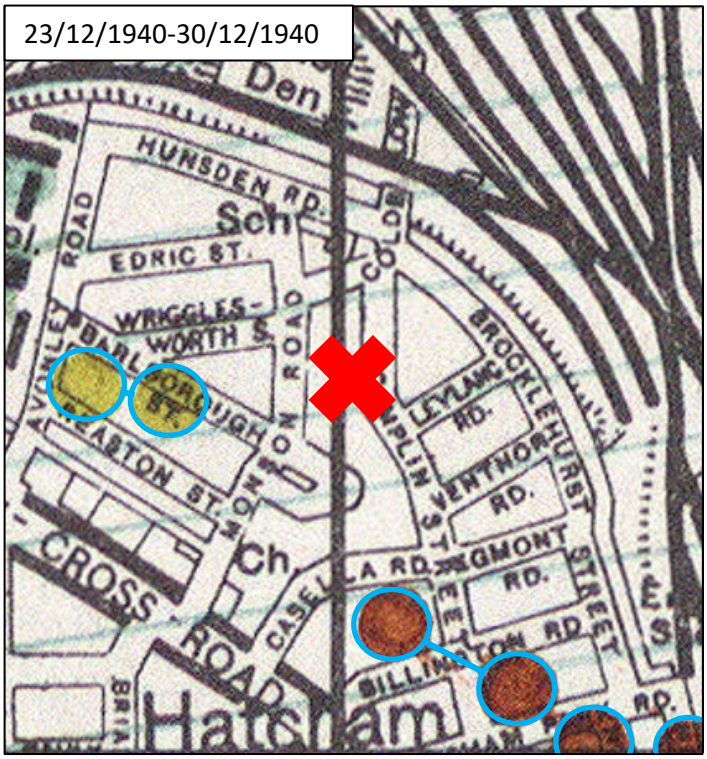
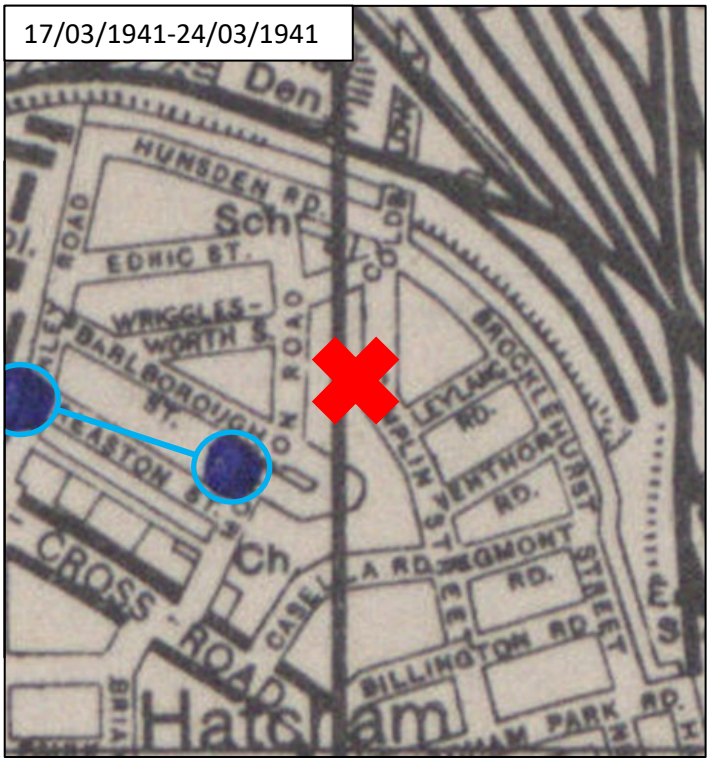
N	**Title:** Weekly Bomb Census Maps – 07/09/1940 - 07/10/1941	**FIGURE: 6.3**

21/10/1940-28/10/1940

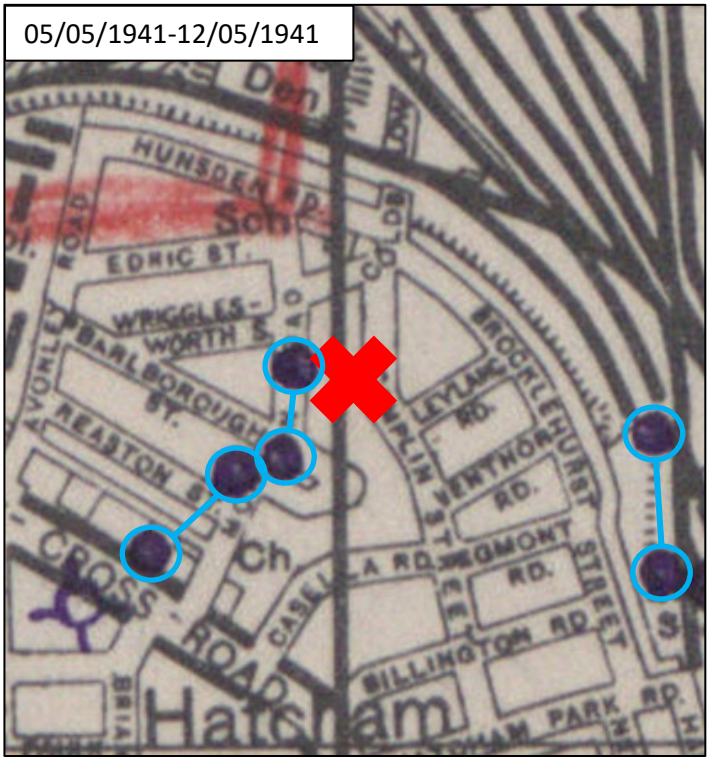
23/12/1940-30/12/1940



17/03/1941-24/03/1941



05/05/1941-12/05/1941



Key:

- Bomb strike (any colour)
- Incendiary bombing (any colour)
- Unexploded oil bomb (any colour)
- Potential bomb-stick

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Location: ✖	Info Source: The National Archives

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Title:	**V1 Bomb Census Mapping**	**FIGURE: 7**

NR V-1 flying bomb strike

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Location: ✖	Info Source: The National Archives

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Title:	London County Council Bomb Damage Map	FIGURE: 8

Key:

- Black: Total destruction
- Purple: Damaged beyond repair
- Dark red: Seriously damaged – doubtful if repairable
- Light red/pink: Seriously damaged – repairable at cost
- Orange: General blast damage – not structural
- Yellow: Blast damage – minor in nature
- Light green: Clearance areas
- Small circle: V2 long-range rocket strike
- Large circle: V1 flying bomb strike

Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Approx. Site Boundary:	Info Source: London Metropolitan Archive

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APPENDICES: 1 - 5

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Recent German UXB Finds in the UK + Historical Analysis

The Ministry of Defence (MOD) says that bomb disposal teams around the UK deal with approximately 60 German WWII-era UXBs per year.

- ***20th February 2024*** – An SC500 (standard 500kg HE bomb) was found during shallow excavations in a residential garden in Keyham, Plymouth. *Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest at approximately 1 to 2m bgl.*
- ***10th February 2023 –*** An SC250 (standard 250kg HE bomb) was dredged out of the River Yare in Great Yarmouth. The UXB detonated unexpectedly in situ during an attempt to disarm it. *Historical Analysis: The UXB landed in the River Yare; the precise location of its initial impact is unknown. UXBs in water are often affected by migration, whereby the item can travel along the riverbed.*
- ***26th February 2021 –*** An SC1000 (standard 1,000kg HE bomb) was discovered during shallow excavations in Exeter, adjacent to the University of Exeter. The item was detonated in situ and caused structural damage to nearby properties, leaving some inhabitable. *Historical Analysis: The UXB landed in undeveloped land of no obvious significance. It came to rest at approximately 2 to 3m bgl with its nose facing upwards, highlighting the potential of J-curve occurring.*
- ***23rd May 2019*** - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Kingston upon Thames, London. *Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest approximately 3 to 4m bgl.*
- ***11th February 2018*** – An SC500 (standard 500kg bomb) was discovered in George V Dock in London during planned work at London City Airport. *Historical Analysis*: *George V Dock was identified as a primary target by the Luftwaffe during WWII and was bombed on multiple occasions.*
- ***15th May 2017 -*** An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Aston, Birmingham. *Historical Analysis: The UXB landed in a small back garden belonging to a terraced house, part of a row. It J-Curved under a neighbouring garden and came to rest at just 1.4m bgl. NB: These houses had not sustained bomb damage.*
- ***2nd March 2017 -*** A 250kg HE bomb was found during deep excavations at a building site in Brondesbury Park, London. *Historical Analysis: UXB landed in a large residential back garden. A single storey building was built on top of the UXB post-WWII.*

Recent Allied UXB finds in Europe

- ***27th June 2024*** – A 250kg HE UXB of Allied origin was discovered in a wooded area in Gruenheide (Germany).
- ***26th April 2024*** – A 500kg American HE UXB was discovered during construction work in Mainz (Germany), nearby the MEWA Arena stadium.
- ***3rd April 2024 –*** A 500kg UXB of Allied origin was discovered during construction work on a shipping channel in Deutz, Cologne (Germany). The device was defused in situ.
- ***28th March 2024*** – A 500lb American HE UXB was discovered during construction work in Aachen (Germany). The device was defused in situ.
- ***11th August 2023 –*** A 250kg HE UXB of Allied origin was discovered in Lublin (Poland). The device was discovered in an area where an aircraft factory had been located prior to WWII.
- ***8th August 2023*** – An unexploded "one-tonne shell" (1000kg HE UXB) of anticipated Allied origin was discovered near Dusseldorf city zoo (Germany).
- ***5th July 2023*** – A UXB of unspecified origin and calibre (alleged to have been Russian but no confirmation) was discovered on a construction site in Hohenschönhausen, Berlin (Germany). The device was defused in situ.
- ***17th March 2022*** – A farmer ploughing a field discovered a British INC30 (incendiary) bomb, which contained phosphorous, in Viersen (Germany). The plough became embedded in the device, which did not explode.

NB: Domestic UXO finds in the UK are too numerous to list. Between 2006 and 2009, over 15,000 items of British / Allied UXO (excluding small arms ammunition) were found on UK construction sites (CIRIA).

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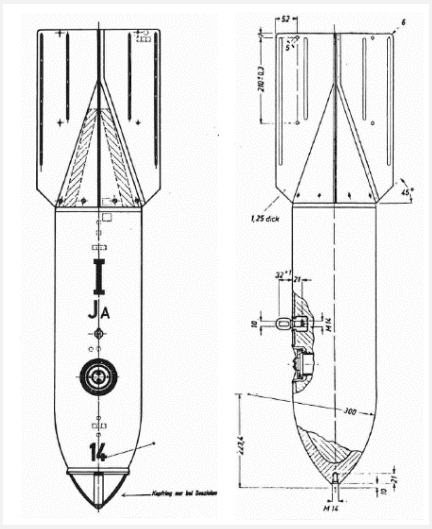
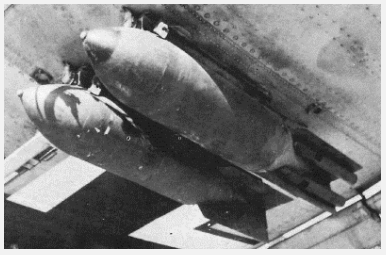
SC 50

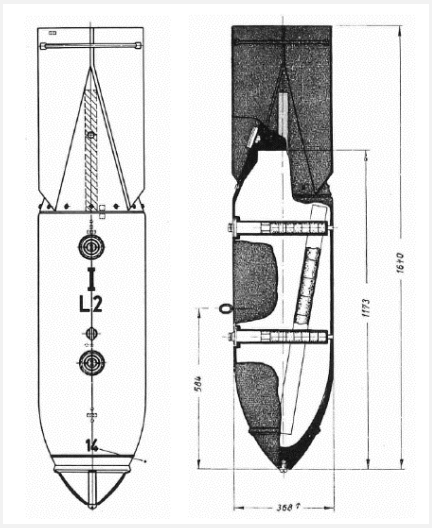
Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	25kg (55lb)
Filling:	TNT, Amatol or Trialen
Charge/Weight Ratio:	46%
Fuse Type:	Electrical impact fuse or mechanical delayed action fuse
Body Dimensions:	1,100mm length x 200mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Additional fittings: Kopfring nose for limited penetration and Stabbo nose for dive-bombing.





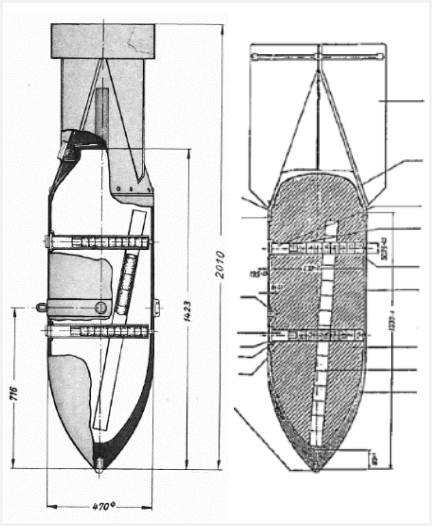
SC 250

Bomb Weight:	245-256kg (540-564lb)
Explosive Weight:	125-130kg (276-287lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	1 or 2 electrical impact fuse(s) or mechanical delayed action fuse(s)
Body Dimensions:	1,173mm length x 368mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Kopfring nose for limited penetration. Stabbo nose for dive-bombing.



SC 500

Bomb Weight:	480-520kg (1,058-1,146lb)
Explosive Weight:	220kg (485lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	2 electrical impact fuses or mechanical delayed action fuses
Body Dimensions:	1,423mm length x 470mm diameter
Appearance:	Bomb body and tail painted grey/green or buff with a yellow stripe on the tail unit. Steel construction.
Variants:	3 x variants. Kopfring nose for limited penetration.



Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Info Source:	*W, Ramsey.1988 / various news sources*

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B-1E Sub-Munition

Bomb Weight: 1-1.3kg (2.2-2.87lb)

Incendiary Weight: 680g (1.4lb)

Filling: Thermite

Fuse Type: Simple impact fuse

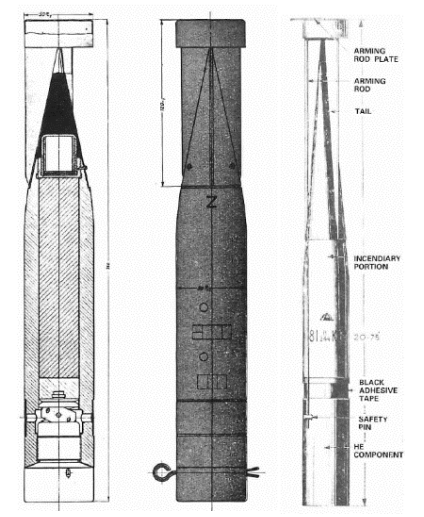
Body Dimensions: 247mm length x 50mm diameter

Appearance: Grey body and dark green painted tail unit. Magnesium alloy case.

Operation: Small percussion charge ignites Thermite (>1,000°C burn).

Variants: Most common variant: B 2EZ (2kg) included a small HE charge

Remarks: Drop containers varied in size. The smallest cluster bomb held 36 x B-1Es and the largest 620 x B-1Es.



Brand C50

Bomb Weight: 41kg (90.4lb)

Incendiary Weight: 13kg (30lb)

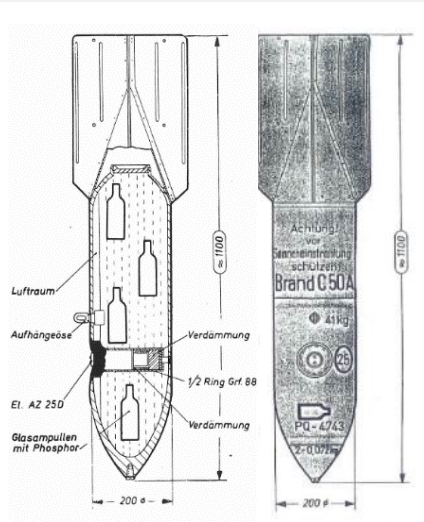
Filling: Main fill (86% Benzine, 10% Rubber) plus 4% Phosphorus in glass bottles

Fuse Type: 1 x electrical impact fuse

Bomb Dimensions: 762mm length x 203mm diameter

Appearance: bomb body and tail painted grey or green with the rear of the bomb painted red and a red band around the centre of the body.

Variants: C 50 B: 77% White Phos fill
C 250 A: 87.7% Petroleum, 11.7% Polystyrene, 0.5% White Phos (185kg version)



Spreng-Brand C50 - *Fire Pot*

Bomb Weight: 34kg (75lb)

Explosive Weight: 9kg (20lb)

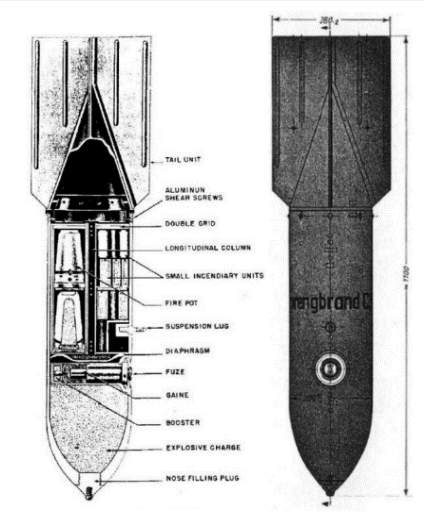
Filling: TNT burster charge, 6 x Thermite containers (fire pots) and 67 x small triangular incendiary elements.

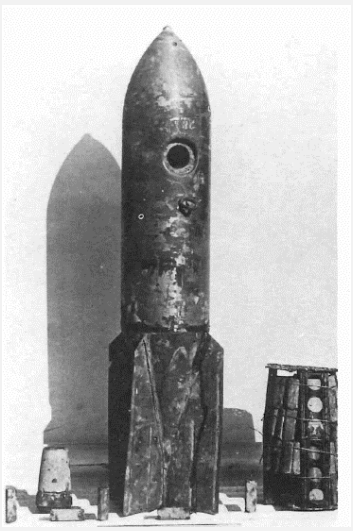
Fuse Type: 1 x electrical impact fuses or aerial burst fuse

Bomb Dimensions: 711mm length x 203mm diameter

Appearance: Bomb body and tail painted grey/green or pale blue with red base plug and red or green incendiary markings. Steel construction.

Operation: A charge blows off the base plate, firing a plume of incendiary mixture 100 yds. Approx 1 second later the HE charge detonates.





Project:	**Land Between 43 and 45 Camplin Street, Lewisham**
Client:	**Lewisham Council**
Report Ref:	**DRA-25-1882**
Info Source:	*W, Ramsey.1988 / various news sources*

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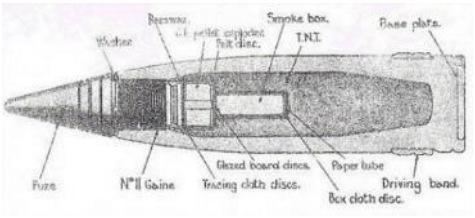
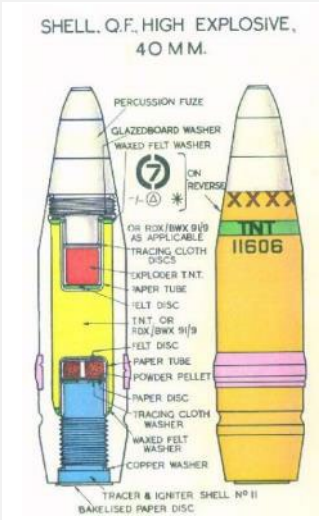
HAA Battery - 3.7" QF Shell

Shell Weight:	12.7kg
Shell Dimensions:	94mm x 438mm
Fill Weight:	1.1kg
Fill Type:	TNT
Fuse Type:	Mechanical Time Delay fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	10 - 20 rpm
Ceiling:	9,000 - 18,000m
Variants:	HE or shrapnel shells. Note, the 4.5" gun was also used in an HAA role throughout the UK.



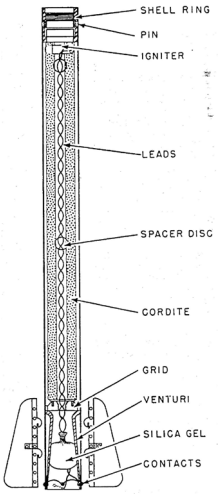
LAA Battery - 40mm Bofors Shell

Shell Weight:	0.84kg
Shell Dimensions:	40mm x 180mm
Fill Weight:	70g
Fill Type:	TNT
Fuse Type:	Impact fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	120 rpm
Ceiling:	7,000m
Variants:	HE or AP shells. Both with rear tracer compartment



Z Battery - 3" U.P Rocket

Rocket Weight:	24.5kg
Warhead Weight:	1.94kg
Filling:	TNT warhead. Black Powder solid fuel rocket motor.
Fuse Type:	Mechanical Time Delay fuse
Rocket Dimensions:	1,930mm x 76mm
Ceiling:	6,770m
Operation:	Fired from single, tandem and (later) 36 x rail launchers (Z Batteries). Limited use throughout the UK.



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AA	*Anti-Aircraft (defences)*
AFS	*Auxiliary Fire Service*
AP	*Anti-Personnel*
ARP	*Air Raid Precautions*
ASW	*Anti-Submarine Warfare*
BDU	*Bomb Disposal Unit (historic term for EOD)*
Bgl	*Below Ground Level*
EOC	*Explosive Ordnance Clearance*
EOD	*Explosive Ordnance Disposal*
FP	*Fire Pot (German bomb)*
GI	*Ground Investigation*
HAA	*Heavy Anti-Air (gun battery)*
Ha	*Hectare (10,000m2)*
HE	*High Explosive*
IB	*Incendiary Bomb*
Kg	*Kilogram*
LAA	*Light Anti Air (gun battery)*
LCC	*London County Council*
LRRB	*Long Range Rocket Bomb (V2)*
LSA	*Land Service Ammunition*
Luftwaffe	*German Air Force*
OB	*Oil Bomb (German bomb)*
PM	*Parachute Mine (German bomb)*
RAF	*Royal Air Force*
RFC	*Royal Flying Corps*
RN	*Royal Navy (British)*
RNAS	*Royal Naval Air Service*
ROF	*Royal Ordnance Factory*
SAA	*Small Arms Ammunition*
SD2	*2kg AP bomb (German bomb)*
SI	*Site Investigation*
U/C	*Unclassified (German) bomb*
UP	*Unrotating Projectile (British 3" AA rocket)*
USAAF	*United States Army Air Force*
UX	*Unexploded*
UXB	*Unexploded Bomb*
UXO	*Unexploded Ordnance*
V1	*German Flying (pilotless) bomb - "Doodlebug"*
V2	*German LRRB - "Big Ben"*
WAAF	*Women's Auxiliary Air Force*
WWI	*World War One*
WWII	*World War Two*

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